NATIONAL MUSEUM OF NATURAL SCIENCES

THE AGE OF DINOSAURS IN CANADA

JANE DANIS

NATIONAL MUSEUMS OF CANADA

NATIONAL MUSEUM OF NATURAL SCIENCES

THE AGE OF DINOSAURS IN CANADA

JANE DANIS

NATIONAL MUSEUMS OF CANADA – OTTAWA – 1973

The Age of Dinosaurs in Canada

National Museum of Natural Sciences
National Museums of Canada
Ottawa, Canada, 1973

Litho in Canada

On the cover:
A carnivorous (flesh-eating) dinosaur of the species *Daspletosaurus torosus* has just finished killing a large horned dinosaur, *Monoclonius lowei* (a plant eater). It is defending its kill against another *Daspletosaurus*. (Neg. 71-4430)

TABLE OF CONTENTS

INTRODUCTION

In the long and exciting history of our earth, man is a newcomer. He has changed the world around him and he often feels that he rules the earth. Many people forget that long before man, many other kinds of animals lived and died on earth. Some left their marks and others disappeared without a trace. Other animals ruled the world in years long past. Among the best known and most exciting of these earlier rulers were the dinosaurs, who roamed the earth many million years before man appeared. The word "dinosaur" was not even included in the dictionary a little more than one hundred years ago, yet today most of us know that these "monsters" once lived over most of the earth. "Dinosaur" comes from two Greek words meaning 'terrible lizard' (deinos-terrible, saura-lizard). Yet dinosaurs were not lizards, but a special group of reptiles.

Like other reptiles such as lizards, snakes,crocodiles, and turtles, they had no hair, breathed air, and laid eggs with hard shells. However, dinosaurs were different from other reptiles in many ways. Many of them walked on two feet. Some kinds grew to a very large size, and there were many differences in the skeleton and skull bones.

Because there are no dinosaurs alive today, all of what we know about them comes from fossils - parts of the animals or marks they made that have become rock.

What are fossils and how are they formed ?

Fossils are the remains of animals and plants that lived long ago and that have somehow been preserved. Fossils are preserved in many ways. Most fossils including dinosaur bones and teeth have been turned into rock.

Many dinosaurs lived on the swampy flatlands by the ocean. When some of the animals died or were killed, their bodies fell into places where mud and sand were being deposited, such as swamps, rivers, or streams. The mud and sand covered the carcass and protected harder parts such as bones and teeth. Although skin and flesh usually rotted away, sometimes the impression of the skin was preserved in the rock (see Fig. 1). Cracks and holes in the bones were often filled with minerals carried in the ground water and the bones themselves were chemically altered. The bones became fossilized or "turned to stone". Many fossil bones are actually rock and are much harder than recent bones. This is one easy way to recognize a fossil bone.

Other kinds of fossils such as insects preserved in amber (fossil gum or resin from trees like pines), shells, fish skeletons and other animal bones, tracks (footprints), trees and leaves are found with the dinosaurs. They often help us understand more about the world in which the dinosaurs lived.

Figure 1. Skin texture of a dinosaur preserved as an imprint in a rock layer. (Geol. Survey of Canada Neg. 50282).

Sand and mud and gravel that are eroded or washed off the land into a stream or swamp or the ocean are called sediments. They commonly form layers like the layers of a cake. Animals die, sink into the mud, and are buried in these layers. Over millions of years these layers have been deposited on the surface of the earth and have become hardened into rock. As time passed oceans retreated and advanced over the land. Mountains were formed and worn away by the erosion of wind and water. Some of these layers of sediments were destroyed and some were deeply buried. So rocks and fossils of different ages are found exposed in different parts of the world.

Canada has some of the finest dinosaur fossils of Cretaceous age in the world. However, not all kinds of dinosaur bones are found in this country. The history in the rocks covering the time of the dinosaurs is incomplete. It is like a book with pages torn out here and there. The story can only be outlined, but not worked out in detail.

How long ago did dinosaurs live and how do scientists tell the age of rocks and fossils ?

To explain the history of the earth and its rocks and fossils, scientists have made charts and divided the earth' s history into sections with the oldest at the bottom (see Fig. 2). We think of time as days, weeks, and years. Paleontologists - scientists who study fossils - think in terms of thousands and millions of years or epochs, periods and eras. These divisions make up the geologic time scale.

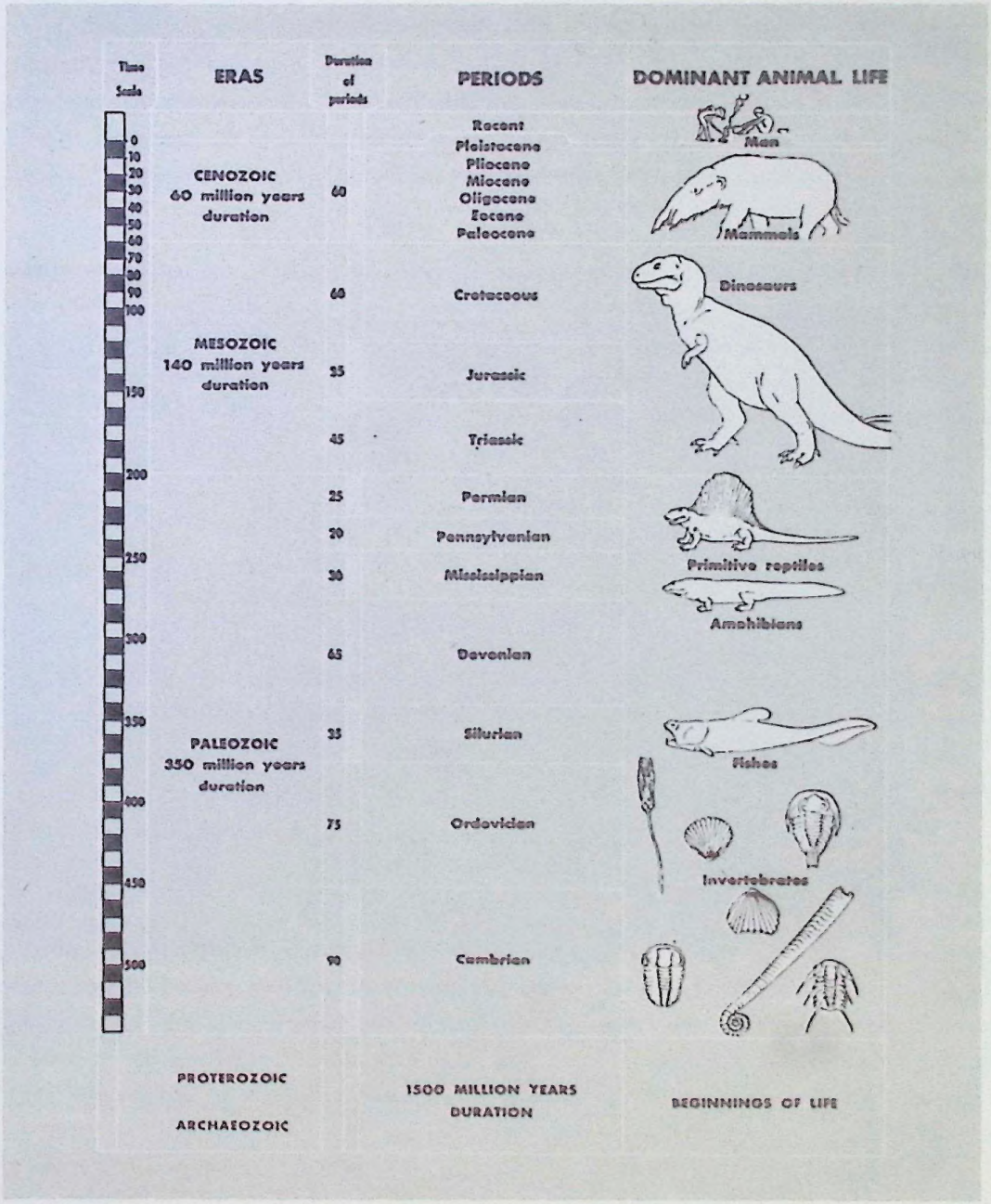

Figure 2. Geological time chart. After Colbert. Courtesy American Museum of Natural History. (Neg. J9958)

The first dinosaurs lived about 220 million years ago in the Triassic Period. They developed and became more widespread in the Jurassic and Cretaceous Periods. Then about 63 million years ago, at the end of the Cretaceous, they died out.

There is no simple way to explain the ways that scientists use to determine the age of the earth and its rocks and fossils. Many methods have added useful information to the earth's history including: 1). observation of processes we see today such as erosion and deposition of sediments. 2). comparison of the positions of rocks and fossils in the layers of the earth. 3). measurement of the half life (rate of decay) of certain radioactive elements that occur in some rocks and fossils.

We can look around us and watch how slowly erosion works to wear down mountains and build up layers of sediments. It is easy to see that it has taken millions of years to form the layers of our earth. However, using this method we cannot tell exactly how many years old the earth is.

Scientists can compare fossils that are found in different layers of sediments and see that some kinds of animals occurred before, at the same time, or after others. They can also study the development of groups of animals down through time, and learn how these animals and their surroundings changed and how long they survived. In this way they can tell which periods of earth history occurred long ago and which occurred more recently.

The most accurate method so far found to tell the exact age of rocks and fossils is by measuring the amounts of certain radioactive elements that they originally contained. These are compared with the amounts of other elements into which they have decayed or deteriorated. Since the speed of decay is constant for each element, the amount of change tells the age of the rock.

We can compare radioactivity to the paint on a wall. When the wall is newly painted, the paint is bright, shiny, and smooth. The next year it has become somewhat tarnished. As time goes by, it cracks and flakes off. When we look at a painted wall it is easy to tell if the paint is new or very old. In the same way a scientist can look at radioactive elements to tell if a rock or fossil is fairly recent or very old.

It is easy to talk about hundreds of millions of years, but it is hard to imagine how much time this actually means. When did dinosaurs live ? Where does man fit in ? One way to picture the history of the world is to compare it to one year (365 days). Let us say that the earth was formed on the first hour of the first day. The oldest known life that has so far been discovered appeared on the 105th day at 4:12 in the afternoon. The first dinosaur appeared on the 349th day at about 6:42 A.M. The last dinosaur to roam the earth died out on the 361st day at 5:06 A.M., and man first arrived 22 minutes before midnight on the very LAST day of the year.

Where do we look for dinosaurs ?

For hundreds of years geologists from many countries have been making maps to show the ages of the rocks that are found all over the world. From these maps paleontologists and others who want to hunt dinosaurs can find out where sediments occur that might contain dinosaur bones. Once the dinosaur hunter knows where such rocks occur, he searchs for exposures where no grass or weeds cover the ground. Then he walks or climbs along the exposures looking for pieces of fossil bone. Where fossil bones are found, the collector studies the ground around them carefully to find out whether they are scattered bones or parts of a dinosaur skeleton. Sometimes when a dinosaur died, the bones were scattered by predators or scavengers before they were buried and only parts were fossilized (see Fig. 3). In rare cases carcasses were buried and nearly complete skeletons are preserved (see Fig. 4).

Figure 3. Scattered bones of a large carnivorous dinosaur *Albertosaurus (Gorgosaurus)* Sand Creek area, Alberta (Neg. 52149)

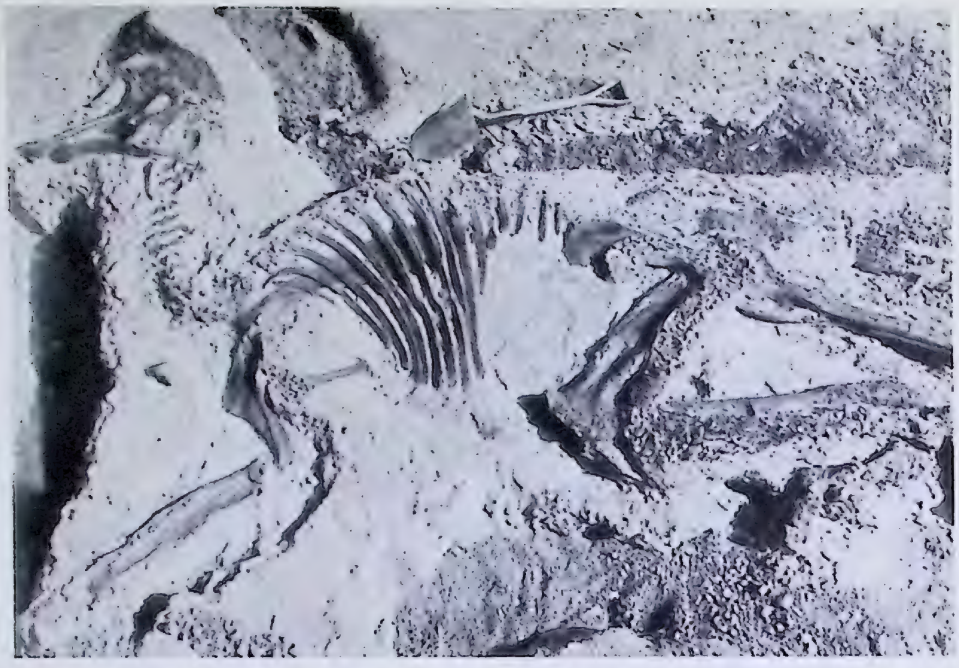

Figure 4. Nearly complete skeleton of a duck-billed dinosaur, *Lambeosaurus*, in place in the rock near Manyberries, Alberta. (Neg. 83381)

If bones are small and isolated, the collector will carefully wrap them in paper and label them for later study. If a dinosaur skeleton is found, fossil hunters may spend weeks or months carefully digging around and hardening the bones with shellac and glue. With some rock still around the bones to protect them, the skeleton is covered by strips of burlap (potato) sacking and soaked in wet plaster, like a cast made for a broken arm or leg. The fossil in its plaster jacket is crated and sent to a laboratory to be prepared and studied (see Fig. 5).

Figure 5. The wrapped skeleton of a dinosaur ready to be transported out of the badlands. (Neg. 29062).

In the laboratory skilled preparators clean off the remaining rock, and repair pieces that have been broken. Then scientists study the bones and the best ones are mounted and prepared for public display. Museum displays allow us to learn more about dinosaurs (see Fig. 6).

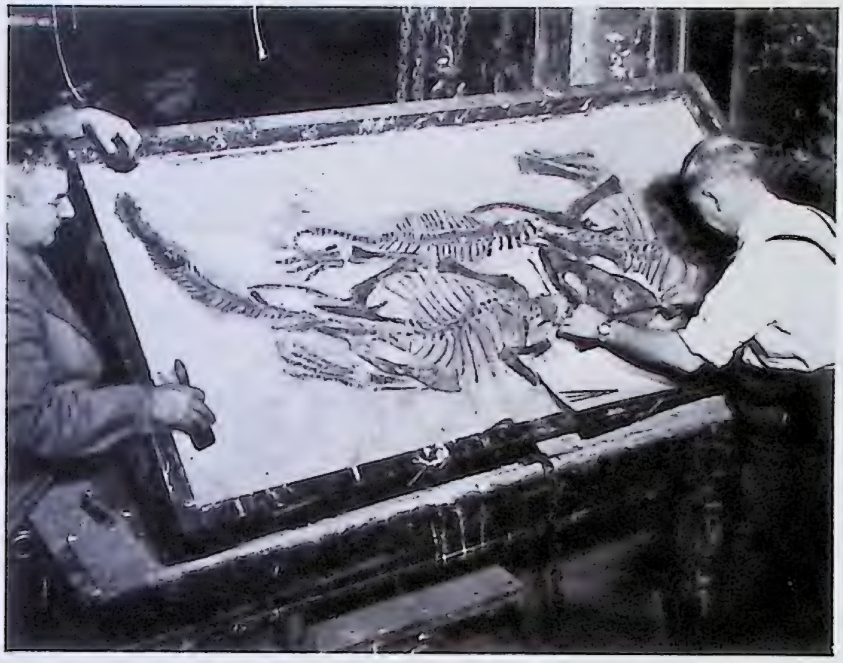

Figure 6. Preparing the bones of a primitive horned dinosaur *Leptoceratops*. (Neg. 102170)

How are dinosaurs named ?

There is a very good reason why dinosaurs have such long and strange sounding names. To be sure that the scientific names of animals and plants are the same in every language, scientists often name them by putting together Greek or Latin words to describe something about each one. For example *Tyrannosaurus* is Greek for "tyrant lizard". *Brontosaurus* means "thunder lizard" and *Triceratops* means "three horned face". Some animals and plants are named in honour of people or places. For example *Lambeosaurus* was named in honour of Dr. Lawrence M. Lambe, a famous Canadian paleontologist. *Edmontosaurus* was named after the Edmonton Formation, which was named after the city of Edmonton, Alberta. All animals and plants have scientific names but we usually use a more common name. For example man is *Homo sapians* "wise man" and a dog is *Canis familiaris* "common dog".

Where and when were the first dinosaurs collected in Canada ?

The first dinosaur bones were found in Canada near Morgan Creek, Saskatchewan in 1874 by G.M. Dawson, a Canadian geologist. In 1884, J.B. Tyrrell discovered dinosaurs along the valley of the Red Deer River in Alberta. Between 1910 and 1917 large, valuable collections of dinosaur skeletons were made along the Red Deer River by two groups. C.H. Sternberg and his sons Charles, George, and Levi represented the Geological Survey of Canada. Barnum Brown and his assistants collected for the American Museum of Natural History in New York. Fine skeletons were collected by parties from the Royal Ontario Museum in Alberta between 1918 and 1922, first led by W.A. Parks and then Levi Sternberg. Canadian dinosaurs are on display in museums in many parts of the world, including Canada, the United States, Argentina, England, and Italy.

GENERAL INFORMATION ABOUT DINOSAURS

How very different the world looked 220 million years ago, when the dinosaurs first appeared! The climate was warm and humid over most of the world. Many familiar plants such as grass did not exist. Instead lush ferns and mossy plants covered the ground.

The first dinosaurs were also very different from the later giants like *Tyrannosaurus* and *Brontosaurus*. They were relatively small active animals, some of which probably ran about on two legs. Reaching three to eight feet in length, they weighed about 40 pounds, about as much as a six or seven year old child. Many of these early dinosaurs were small meat eaters such as *Coelpphysis* (see Fig. 7). This fierce little predator ate lizard-like and other small animals that scurried about.

Figure 7. The Triassic dinosaur, *Coelophysis*, after Colbert.

Late in the Triassic Period the first mammals appeared. They looked like mice and rats, and rushed around to avoid the larger reptilian predators. Their food seems to have been smaller animals, insects, and the eggs of larger reptiles.

Tracks and bones of Triassic dinosaurs have been found in Nova Scotia and in the eastern and southwestern United States as well as in other parts of the world.

As time passed the scene changed. Dinosaurs grew larger and different kinds appeared. In the Jurassic a large, shallow, warm sea flooded much of western North America. In flood plains criss-crossed by streams and rivers, huge harmless planteating dinosaurs (sauropods) such as *Brontosaurus*, *Diplodocus*, and *Brachiosaurus* waded in the rivers and streams and ate the soft water plants. These giants must have weighed from 20 to 40 tons - about five to ten times as much as a big elephant - and were 70 to 90 feet long - as long as six cars parked end to end. They had a long neck (as long as 20 feet), a relatively tiny head, and a long heavy tail. These were the largest animals that ever walked on land. However, when on land they were in constant danger. With their long necks stretched above the trees, they kept a close watch for hungry meat eaters such as *Allosaurus*. These gentle giants were nevertheless able to move easily on land and may have stayed together in groups for protection.

To survive on land some dinosaurs developed peculiar defences. One such beast was the herbivore *Stegosaurus*. It had two rows of bony plates, which may have stood almost vertical, and extended down its back from head to tail. The plates near the head were small, but over the hind legs they were two feet long and several inches thick. Along its tail were two pair of long, sharp, bony spikes. A powerful blow from that spiked club would have been painful and discouraging even to the largest carnivorous enemy (see Fig. 8). This bulky beast was 20 feet long and weighed about two tons. However, it had a very small head, only 16 to 20 inches long.

Figure 8. A model of *Stegosaurus*

On the land the giant flesh eater *Allosaurus* stalked its prey which included *Brontosaurus* and its giant relatives. This fierce beast was 30 feet long and stood nearly 10 feet high. It walked about on its hind legs and had huge sharp claws on its front feet well equipped for tearing flesh. However, its hind legs were much shorter relative to the length of the animal than in the later *Tyrannosaurus*, and *Allosaurus* was probably not nearly as agile. The skull of *Allosaurus* was more than two feet long and had sharp cutting teeth three inches long - as long as the blade of a pocket knife.

Ceratosaurus, a smaller relative, (16 feet long and eight feet high) had a small bony horn on its nose. It was the only carnivorous dinosaur to have such a horn, although some later herbivores (the horned dinosaurs) had nose horns.

On a smaller scale than *Allosaurus* but equally fierce were the smaller carnivorous dinosaurs. They were animals like *Coelophysis* of the Triassic (see Fig. 7). *Ornitholestes* was typical of these dinosaurs. It was about six feet long and was bipedal. These smaller hunters depended on speed and the ability to hide in the underbrush to protect them from the giant carnivores. They probably fed on smaller dinosaurs, lizards, small mammals, flying reptiles and early birds.

While fossil bones of these Jurassic dinosaurs occur in the western United States, none have so far been discovered in Canada. It is the Cretaceous or later dinosaurs that are commonly found in western Canada.

In the Cretaceous the huge tropical inland sea extended further over western North America. The land was dominated by the largest and fiercest killer of all. This monster was about 45 feet long, stood 18 feet tall to the head, and weighed nearly eight tons - as much as two large elephants. Its skull was huge, more than four feet long. Its sharp cutting teeth were six inches long, as long as the blade of a hunting knife. The edges of the teeth were serrated like the blade of a saw. Only the tiny front legs of *Tyrannosaurus* were smaller than those of the earlier meat eater *Allosaurus*. However, the huge, powerful, hind legs made *Tyrannosaurus* much more agile, and those six inch long teeth were certainly all the weapons the giant predator needed. The same can be said of slightly smaller but close relatives of *Tyrannosaurus* such as *Albertosaurus (Gorgosaurus)* and *Daspletosaurus*.

Ever weary of the giants, the smaller lighter predators hunted their prey. Theornithomimid, or bird-mimic dinosaur probably ate eggs and bugs. They had no teeth to chew meat or plants, but had a bird-like beak. In fact its body looked like a large ostrich with a long tail.

The huge plant-eating dinosaurs like *Brontosaurus* had all but died out in most of North America by Cretaceous time and were restricted to more tropical areas. They were replaced in the north by a great variety of herbivorous dinosaurs of smaller size and different habits in and around the Cretaceous swamps and plains.

Duck-billed dinosaurs were large lumbering beasts which shovelled up soft plants from the bottom of the swamp as ducks do today, but they had rows of teeth (from 200 to 400) set back along the jaw to chew coarser water plants (see Figs. 9 and 10). These animals were 25 to 40 feet long and weighed four to six tons - the same or more than a large elephant.

Figure 9. The skull of a duck-billed dinosaur, *Anatosaurus* (Neg. 54976)

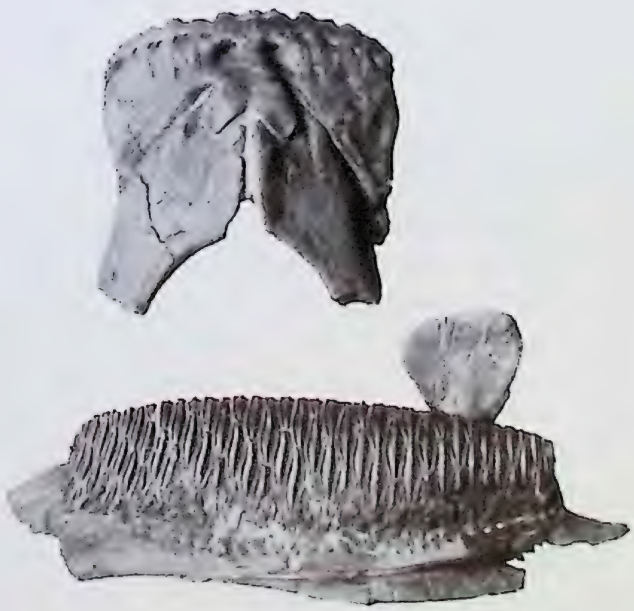

Figure 10. Beak and lower jaw of a duck-billed dinosaur, *Corythosaurus*, showing the arrangement of teeth in rows. (Neg. 77524)

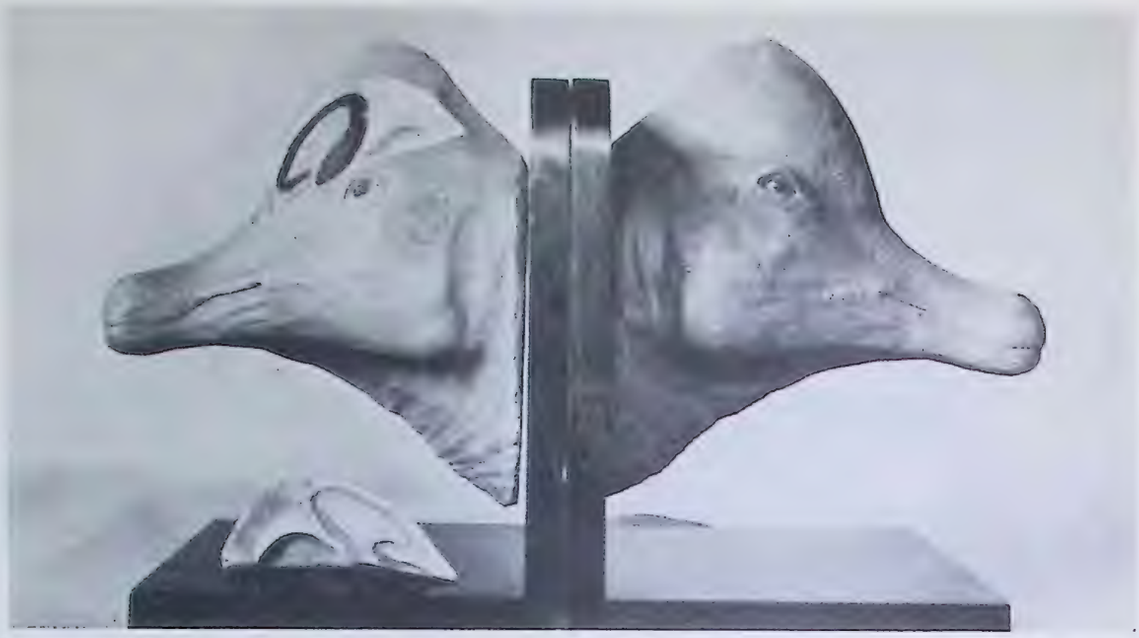

Figure 11. Model of the head of a duck-billed dinosaur, *Corythosaurus*, showing hollow skull areas or passages. (Neg. 97183)

Some hadrosaurs developed hoods or crests on their heads that contained hollow areas or passages (see Fig. 11). There have been several possible explanations for these peculiar structures. Perhaps they were sound producing chambers, so that the animal could bellow fiercely to scare off its enemies or attract others of its kind. It might also have given the animal a better sense of smell. It has been suggested that they were air storage chambers for use when the animal had its head underwater. However, it would have held so little air, it is doubtful it would have been of much use.

Other herbivorous dinosaurs spent their time on land and so nature supplied them with different kinds of defences against the giant prowling carnivores. One kind, the armoured dinosaurs must have looked like army tanks as they lumbered over the ground. They had a low flattened body and walked on four feet like a turtle. However, in place of the shell they had a protective covering of thick bony plates all over their back and down the tail. Some kinds like *Ankylosaurus* had a huge club of bone at the end of their tail, and rows of sharp spikes along each side of their body. Other kinds had no tail club but had longer sharper spikes along their sides. These tanks were only about 15 feet long, but with all that bony armour they must have weighed up to four tons.

A common group of plant-eaters were the horned dinosaurs (ceratopsians) which included *Triceratops*. These dinosaurs had a heavy body and walked on four legs. Huge shields of bone extending back from the skulls protected the back of their necks. Some Ceratopsians like *Triceratops* had horns over their eyes and nose. Horned dinosaurs developed a hard pointed beak like a snapping turtle, so that they could cut through coarse, thick stemmed plants. They ranged in size from small forms like *Leptoceratops* which was only six feet long and

weighed about 200 pounds, to *Triceratops* whose huge skull alone was seven feet long. Its entire body was 25 feet long and it weighed nine tons. A small and primitive ceratopsian was the famous *Protoceratops* found in the Gobi Desert in Mongolia in Asia. Among the remains of this animal found were eggs and very young animals.

A lesser known group of herbivorous dinosaurs were the bone-headed dinosaurs. A small form called *Stegoceras* was about six to ten feet long and walked on its hind feet. It had a skull about eight inches long with a three inch cap of bone on the top of its head. A larger beast *Pachycephalosaurus* is known only from one well preserved skull and from skull fragments, so scientists are not sure what its body looked like. The dome-shaped skull was more than two feet long and the cap of bone on top was nine inches thick.

What do we know about things like colour or brain size in dinosaurs or about their nests or eggs?

Because dinosaurs are extinct, we cannot observe their habits or their actual appearance. It is impossible to tell from fossils what colours dinosaurs were, whether they had spots or stripes, or what kind of sounds they might have made. Scientists and artists can only assume that they were coloured to blend in well with their surroundings like living reptiles. For many dinosaurs, as for many modern animals, colour was an important aid to their survival. A small, brownish dinosaur that blended in well with the surrounding forest or swamp plants would have been less likely to attract the attention of a hungry predator.

Unlike man and other mammals some dinosaurs had relatively small brains compared to the size of their bodies and seem to have been slow witted. Scientists can determine the approximate brain size of a dinosaur by measuring the volume (space) it took up in the skull. The large dinosaurs had comparatively very small brains. For example the brain of *Tyrannosaurus* was not much larger than that of a common house cat. *Stegosaurus* and *Triceratops* had brains no bigger than a large walnut. It is not surprising that large dinosaurs had a "second brain" or enlargement of nerves far back in their spine to help control their massive hind legs and tails. Some of the smaller dinosaurs, however, had much larger brains. The ostrich-mimic dinosaur, for example, had a brain as large as that of an ostrich. *Stenonychosaurus* a Cretaceous dromeosaur had even a larger brain relative to the size of its body and was probably one of the "cleverest" of dinosaurs.

Because most reptiles lay hard shelled eggs, paleontologists believe that most dinosaurs laid eggs in some form of nests in the dirt or mud. Some dinosaur eggs, nests and baby dinosaurs have actually been found. Although small pieces of dinosaur egg shell are not uncommon, whole dinosaur eggs are very rare. None in good condition has ever been found in Canada. Whole dinosaur eggs have been found in Utah (U.S.A.), France, Spain and Portugal, Mongolia, and China.

In the dinosaur-bearing rocks of the deserts and mountains of Mongolia and China in Asia, nests of eggs of *Protoceratops*, a small horned dinosaur, sauropods and other as yet unidentified types have been discovered. The eggs of *Protoceratops* are eight inches long, only slightly more than twice the size of a large chicken egg. They are oblong in shape with a rough wrinkled surface. The crude nests contained 12 or more eggs each. The size of the egg suggests that a newly hatched *Protoceratops* was about 10 to 12 inches long. From this the animal grew to an adult six to eight feet long. In comparison you might think that the eggs of the giant dinosaurs were huge. But this does not seem to be so.

Complete eggs of *Hypselosaurus*, a smaller relative of *Brontosaurus* have been found in France. They are nearly round and about 10 inches long. From a newly hatched dinosaur about 15 inches long came an adult *Hypselosaurus* about 40 feet long. This is 32 times its birth length. If a man grew that much, he would be as tall as a four storey house.

Actually the size of a hard shelled egg is limited by nature to about 10 inches. The shell is porous and must be thin enough to let air pass between the embryo and the outside, and to allow the hatching animal to break out. However, it must be thick enough to hold the weight of the liquid inside without breaking. An egg of a larger size would kill the embryo inside, if the shell were thick enough to contain the liquid. Even the large dinosaurs like *Brontosaurus* and *Brachiosaurus* hatched from eggs only about 10 inches long.

Like other reptiles, newly hatched dinosaurs probably were fully developed, had their eyes open, and were ready to take care of themselves as soon as they left the egg. However, because of their size, they would have been easy prey for the smaller carnivorous dinosaurs as well as other reptiles like crocodiles.

THE OLDEST DINOSAURS IN CANADA

The oldest dinosaur bones in Canada occur in the cliffs along the eastern shore of the Bay of Fundy in Nova Scotia. These dinosaurs lived about 200 million years ago in Triassic time. The most common types were the small carnivores like Coelophysis (see Fig. 7). Small plant-eating dinosaurs about the size of a turkey were rarer.

Bones of other large Triassic reptiles besides the dinosaurs have been found in Nova Scotia. They included reptiles like large horned toads, crocodile-like animals, and mammal-like reptiles.

The climate in Nova Scotia was very different then. Triassic animals lived in a hot, humid, almost tropical climate for they lived near the equator of that time. This is suggested by the red rock in which the fossils are preserved. The plants of the area would have seemed very strange to us. Ferns that grew as tall as trees were common, as well as the smaller ferns and horsetail rushes. Trees that resembled peculiar palm trees grew along the streams and conifers (early kinds of fir trees) grew in the higher areas.

Only isolated waterworn dinosaur bones have been found in Nova Scotia, not complete skeletons. This could mean that the dinosaurs lived on higher ground away from the rivers and streams. Perhaps only when the bodies were scattered by predators or scavengers, were bones carried or washed into places where they could be fossilized.

After the time the dinosaurs lived in Nova Scotia, there is a gap of 120 million years in the history of dinosaurs in Canada. Dinosaurs must have lived in Canada during that time, but the rocks containing these bones were either eroded away long ago or are still buried deep in the earth. Therefore Jurassic dinosaurs like *Brontosaurus* and *Allosaurus* have not been found in Canada.

THE DINOSAURS OF WESTERN CANADA

In section 2, we had a general look at the kinds of dinosaurs that lived during the Cretaceous Period. Now we will take a closer look at the area in Canada where they lived, the kinds of dinosaurs that lived there, and the other animals that lived around them.

About 82 million years ago during Cretaceous time, as we have seen, a large, shallow, subtropical sea covered the west-central part of North America from the Arctic Ocean to the Gulf of Mexico. The Rocky Mountains rose west of this sea. Sand and mud carried down from the mountains by rivers and streams formed large flood-plains along the western edge of this ocean (see Fig. 12). Some of the finest dinosaur fossils in the world and about 70% of the late Cretaceous dinosaurs of North America come from these ancient lowlands. in Alberta and Saskatchewan. From time to time the sea flooded the flatlands and layers of sediments containing sea shells and sea animals are sandwiched among the layers containing dinosaur bones.

The southern parts of these provinces are now covered by grassy prairie and the ancient lowland rocks are buried. However, where rivers such as the Red Deer River have cut deep valleys down through the layers of rock in Alberta, dinosaur-bearing deposits have been exposed. These regions are characterized by sheer cliffs of beautiful layers of multicoloured rocks worn into strange shapes by wind and water. Such areas are called badlands (see Fig. 13).

In these swampy flatlands the ground was covered with ferns and mosses. Cat tails, willows, and other swamp trees much like those that grow in the Louisiana bayous (swamps) today, grew along the edges of the swamps. Fir trees and broad-leafed trees such as oaks and maples grew in higher places (see Fig. 14).

Figure 12. The location of the shallow, subtropical sea in North America in the late Cretaceous. The lines represent the eastern extensions of the flood plains at various times.

Figure 13. The badlands of Alberta. (Neg. 81538)

Figure 14. Habitat model of the Cretaceous Alberta lowlands with *Gorgosaurus* and *Chasmosaurus*, in the National Museum of Canada, Ottawa. (Neg. 95406)

At least eight major groups of dinosaurs lived in the swamps and forests. *Tyrannosaurus* did live in Canada, however, his smaller relatives *Albertosaurus* and *Daspletosaurus* were apparently much more common. These 16 foot high giants must have been a terrifying sight as they crashed through the brush and along the edge of the swamps in search of food (see Figs. 14 and 15). Even the smaller carnivores and ostrich-mimic dinosaurs (see Fig. 16) kept out of their way.

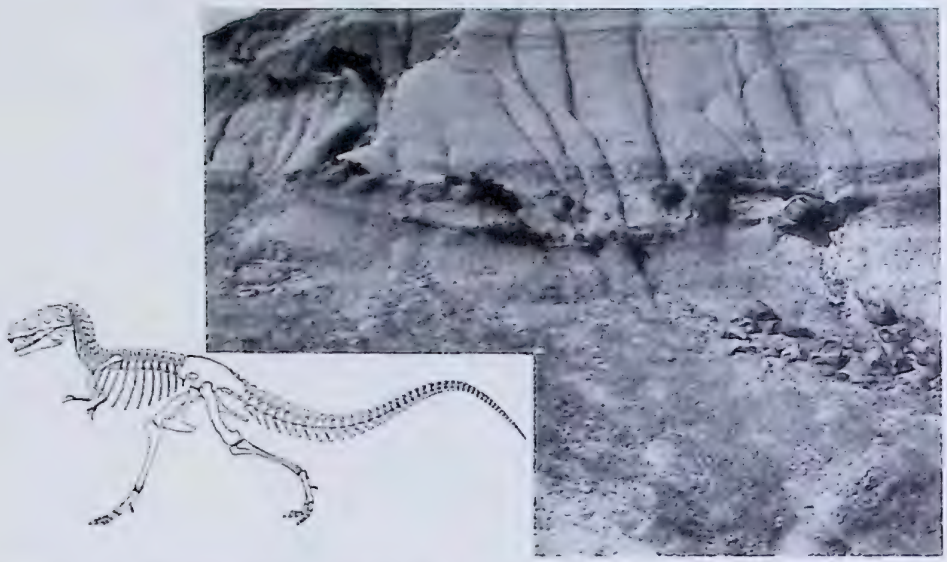

Figure 15. *Albertosaurus skeleton* weathering out of the rock. One hind foot is exposed and broken ends of ribs and other bones may be seen to the left of it. To the left of the photograph is an outline drawing of the skeleton of one of the giant carnivores. (Neg. 23928 & J4520)

Figure 16. Skeleton of an ostrich-mimic dinosaur, mounted in the Royal Ontario Museum. Courtesy Royal Ontario Museum. (Neg. 103511)

To smaller animals like mammals, lizards, flying reptiles and birds, the small but equally fierce dromaeosaurs must have looked equally as frightening. To a 5 to 10 inch long mammal or lizard, a four foot tall hunter would have looked like a four story building to a man. Several kinds of the small lightly-built meat eaters must have lived in Canada because a few of their bones have been found. However, in many cases only enough is known, to make paleontologists eager to find and learn more.

A wide variety of herbivorous dinosaurs lived in and around the Alberta and Saskatchewan flatlands. One of the most common groups were the duck-billed dinosaurs. There were two distinct types found in Canada - the flat-headed and the hooded or crested (see Fig. 17).

Parasaurolophus *Lambeosaurus* (42541) *Corythosaurus* (GSC 77939)

Figure 17. Different kinds of duck-billed dinosaurs.

The flat-headed forms included animals like *Edmontosaurus* (see Fig. 18).and *Anatosaurus*. Among the strange looking hooded or crested dinosaurs were *Lambeosaurus*, *Corythosaurus* and *Parasaurolophus* (see Fig. 17).

Figure 18. A reconstruction of the duck-billed dinosaur, *Edmontosaurus*.

The other common type of herbivorous dinosaurs were the horned dinosaurs. Several kinds of ceratopsians lived in Canada. The smallest type was *Leptoceratops*, which had only a hint of a bony neck shield and no horns (see Fig. 19). Most of the horned dinosaurs, however, were larger and heavier with big bony shields and horns. An earlier form *Centrosaurus* had a long nose horn and only shorter blunt horns over the eyes. Triceratops, on the other hand, had a small nose horn and horns three feet long - as long as a sword - over the eyes. These would have been quite a weapon even against the largest meat eaters (see Fig. 19). *Styracosaurus* had long spikes along the back of its neck shield as well as a long nose horn (see Fig. 20). Another peculiar type *Pachyrhinosaurus* had a big lump or ridge of bone extending down along its nose in place of a horn (see Fig. 19). The horned dinosaurs seem to have been similar in appearance and habits to the modern rhinoceros.

Figure 19. Models of the heads of four horned dinosaurs 1). *Triceratops* 2). *Leptoceratops* 3). *Centrosaurus* 4). *Pachyrhinosaurus*. (Neg. J10014)

Figure 20. A reconstruction of the horned dinosaur, *Styracosaurus* (Neg. J10011).

Tank-like armoured dinosaurs also lived in Canada. Two typical kinds were *Panoplosaurus* and *Ankylosaurus*. Both animals had heavy bony plates covering their back, but their other armour differed. *Panoplosaurus* had long sharp bony spikes along each side of its body, but lacked a heavy bony tail club. *Ankylosaurus* had shorter smaller spikes along the body and a large heavy tail club (see Fig. 21).

At least two kinds of small plant-eating dinosaurs probably lived on higher ground away from the swamps. One was the small dome-headed dinosaur *Stegoceras* (see Fig. 22). The other was a hypsilophodont dinosaur called *Thescelosaurus* . This dinosaur may have been similar in its habits to modern pigs (see Fig. 23).

Figure 21. Armoured dinosaurs in their natural habitat. After Matthew. Courtesy American Museum of Natural History. (Neg. 77048)

Figure 22. Skeleton of the small dome-headed dinosaur. *Stegoceras* . After Gilmour. Courtesy University of Alberta. (Neg. J9960)

Figure 23. Model of *Thescelosaurus*. (Geol. Survey of Canada No. 81387)

Small mammals, ranging from mouse to cat size also lived in western Canada during the Cretaceous. They probably ate dinosaur eggs, and smaller animals like lizards, snakes and salamanders. In the swamps were many kinds of turtles, crocodiles, a little alligator-like beast with a long thin nose called *Champsosaurus*. Several kinds of fish like the gar pike, sturgeon, and bowfin lived there as well. Mosquitos, biting flies, and many other insects swarmed in the warm marshlands. Remains of all these animals and various plants are often found with dinosaur fossils. Some of the plants were fossilized in the form of coal. Large and small coal seams are common in Alberta and Saskatchewan. Sometimes when mining coal, the miners came across huge fossil tree stumps four to six feet across. These were once part of the ancient swamp forest, which included tropical redwood, bald-cypress and gum trees. On the higher ground the forests were made up of such trees as magnolias, palms, elm, ash, and birch.

In the air there were flying reptiles and birds. However, virtually nothing is known about the kinds that lived in what is now Alberta and Saskatchewan. Only one identifiable flying reptile bone has so far been found in Canada.

Huge marine reptiles occupied deeper parts of the Cretaceous sea covering eastern Saskatchewan and Manitoba. Great marine lizards called mosasaurs reached a length of 20 to 25 feet. They had long, scale-covered bodies rather like the monitor lizard. In place of legs, they had developed paddles or flippers. They had long sharp teeth and were meat, fish, and shellfish eaters.

Another group of ocean giants were the plesiosaurs. These strange animals had a body like a turtle and a long snake-like neck and tail. Reaching lengths of 40 feet or more, they fed on the fish that lived near the bottom in the shallower parts of the sea. Fossils of these ocean giants are found in eastern Saskatchewan and Manitoba.

This special group of reptiles showed all promises of surviving indefinitely. However, about 63 million years ago, the dinosaurs became extinct, leaving only a relatively few reptiles like lizards, crocodiles and turtles to carry on the tradition.

EXTINCTION OF THE DINOSAURS

Why did the dinosaurs become extinct ?

It would be very useful if we were able to look back into the world of 63 million years ago to see for ourselves why these great animals died out so suddenly. Because that is not possible, scientists have only the clues in the fossil record to go by. It is important to remember, that not only the dinosaurs became extinct. Several major changes occurred at that time. In addition to the dinosaurs, the giant marine reptiles such as mosasaurs and plesiosaurs disappeared completely, Many types of land plants, especially flowering plants, and animals common in the oceans such as ammonites and many kinds of plankton died out. However, other groups of animals like turtles, lizards, crocodiles, birds and mammals did not die out and are still alive today.

There appears to be no simple answer at present as to what happened at the end of the Cretaceous. Several possible reasons have been suggested for the disappearance of the dinosaurs. Perhaps the climate became colder and the dinosaurs could not adapt fast enough to the change. Water temperature might have also become colder, this would have affected the tender plants that many of the herbivores fed on. If the large plant eaters died off, the giant meat eaters would be left without enough food and would soon have died too. A few small mammals or lizards would hardly have been a meal for a hungry *Tyrannosaurus* . Other problems for the dinosaurs might have included changes that affected the dinosaur eggs. Colder weather might have caused the dinosaur to lay fewer eggs. Because many smaller animals ate dinosaur eggs, fewer survived to hatch. With changes on the land and in the water there might have been chemical changes as well. Perhaps the plants or the water had different amounts of vitamins or minerals. This could have meant that the dinosaur egg shells were not as hard and so fewer lived to hatch.

All these things could have affected the dinosaurs and reduced their numbers. However, most scientists feel that none of these factors explain the other equally big changes that took place. It is as though the earth was struck a major, unexpected, environmental "blow" - a quick change in climate, perhaps, or a major change in the air around the earth ? As yet we do not know. Perhaps it will be one of you who in later years solves this famous mystery.

AREAS WHERE TO SEE DINOSAUR BONES IN CANADA AND MUSEUMS TO VISIT

Now that you have read something about the dinosaurs of Canada, perhaps you will be better able to appreciate the fossils displayed in our various museums. The story of the dinosaurs that once lived in Canada is more fully explained in organized museum displays. However, there is nothing more exciting for a "dinosaur fan" than to see fossil dinosaur bones newly exposed in the rocks and cliffs. It is quite a thrill to pick up a piece of rock and realize that it represents a part of a dinosaur that once walked about and breathed.

If you live in or visit western Canada, here are a couple of suggested places to visit to see dinosaur bones. Dinosaur Provincial Park - just north-west of Brooks, Alberta, and about 25 miles north of the Trans-Canada highway - has interesting displays on dinosaurs and dinosaur bones and skeletons prepared and displayed in the rock. You can also wander along the trails and see dinosaur and other kinds of fossil bones and teeth in the rocks. However, you cannot collect the bones, because it is a provincial park and they are preserved and protected for everyone to enjoy.

The town of Drumheller, in the badlands of Alberta, northeast of Calgary, is also an ideal place to see dinosaur bones. There is a local museum with displays on the dinosaurs of the area and useful information about fossils.

It is important to remember that dinosaurs are only one kind of fossil to observe in Canada. You can collect interesting rocks and fossils in most parts of the country. By inquiring to museums, universities, or the government offices in your area, you can obtain useful information about local rocks and fossils.

Always keep in mind that fossils you find may be important. Not only paleontologists find rare or important fossils. Several valuable fossils have been found and reported in Alberta by informed and interested amateurs of fossils. Mrs. Hope Johnson of Ralston, Alberta recently found the first (and so far only) flying reptile bone in Canada, and generously presented it to the Alberta Provincial Museum and Archives in Edmonton. Mrs. Irene Vanderloh found foot bones of the rare carnivorous dinosaur *Stenonychosaurus* on the north bank of the Red Deer River west of Jenner Ferry. When she discovered the importance of her find, she graciously led a party from the National Museum of Natural Sciences, to the site and additional parts of the skeleton were collected.

If you find a dinosaur bone or other fossil that you feel might be important, report it right away to a museum or university in the area. It is important to note the exact place where the fossil was found. A mistake of a few yards or even a few layers of rock could mean a difference in age of thousands or even millions of years.

Where are museums and universities in Canada ?

Museums:

The National Museum of Natural Sciences, Ottawa, Ontario
Royal Ontario Museum,Toronto, Ontario
Nova Scotia Museum, Halifax, Nova Scotia
McGill University Museum, Montreal, Québec
Museum of the Province of Quebec, Québec City, Québec
The New Brunswick Museum, St. John, New Brunswick
The Manitoba Museum of Man and Nature, Winnipeg, Manitoba
Saskatchewan Museum of Natural History, Regina, Saskatchewan
Provincial Museum of Natural History, Victoria, B.C.

Universities:(only a representative sample)

University of British Columbia, Vancouver, B.C.
University of Alberta, Edmonton, Alberta
University of Calgary, Calgary, Alberta
University of Saskatchewan, Saskatoon and Regina, Saskatchewan
University of Manitoba, Winnipeg, Manitoba
University of Toronto, Toronto, Ontario
McMaster University, Hamilton, Ontario
Ottawa University, Ottawa, Ontario
McGill University, Montreal, Québec
Laval University, Québec City, Québec
Dalhousie University, Halifax, Nova Scotia

ACKNOWLEDGEMENTS

I am indebted to Drs. D.A. Russell and Dick Harington of the National Museum of Natural Sciences, Ottawa, who read and criticized the manuscript and offered invaluable suggestions and additional information.

APPENDIX

Glossary of dinosaur names

Animal	Phonetic spelling	Meaning
Albertosaurus	al-BER-tuh-SAW-ruhs	Alberta lizard
Allosaurus	AL-uh-SAW-ruhs	other lizard
Anatosaurus	uh-NAT-uh-SAW-ruhs	goose lizard
Ankylosaurus	AN-kii-loh-SAW-ruhs	stiff lizard
Apatosaurus	uh-PAT-uh-SAW-ruhs	unreal lizard
Brachiosaurus	BRAK-ee-oh-SAW-ruhs	arm lizard
Brontosaurus	BRONT-oSAW-ruhs	thunder lizard
*(Apatosaurus)***		
Centrosaurus	CENT-tra-SAW-ruhs	spiked lizard
Ceratosaurus	seh-RAT-uh-SAW-ruhs	horned lizard
Chasmosaurus	CHAS-muh-SAW-ruhs	lizard with an opening
Coelophysis	see-loh-FY-ses	hollow form
Corythosaurus	kuh-RITH-uh-SAW-ruhs	lizard with a hat
Daspletosaurus	des-PLET-uh-SAW-ruhs	horrible lizard
Diplodocus	dih-ploh-DAHK-uhs	double beam
Edmontosaurus	ed-MON-to-SAW-ruhs	Edmonton lizard
Gorgosaurus	Gor-go-SAW-ruhs	Gorgon's lizard
*(Albertosaurus)***		
Hypselosaurus	hip-SEL-uh-SAW-ruhs	high lizard
Lambeosaurus	LAM-bee-uh-SAW-ruhs	Lambe's lizard
Leptoceratops	Lept-o-SERR-uh-tahps	thin horned face
Monoclonius	MANH-uh-KLOH-nee-uhs	one branch
Ornitholestes	or-NITH-o-LEH-steez	bird catcher
Pachycephalosaurus	PAK-ee-SEF-al-uh-SAW-ruhs	massive headed lizard
Pachyrhinosaurus	PAK-ee-RY-no-SAW-ruhs	thick nosed lizard
Panoplosaurus	pan-NO-plo-SAW-ruhs	completely armoured lizard
Parasaurolophus	par-uh-sawr-AHL-uh-fuhs	parallel crested lizard
Protoceratops	PROCH-toh-SERR-uh-tahps	first horned face
Stegoceras	ste-GAH-serr-us	horned roof
Stegosaurus	STEG-uh-SAW-ruhs	roofed lizard
Stenonychosaurus	sten-NON-ee-co-SAW-ruhs	narrow clawed lizard
Styracosaurus	sty-RAK-uh-SAW-ruhs	lizard with spears
Thescelosaurus	THES-sla-SAW-ruhs	marvellous lizard
Tyrannosaurus	ty-RAN-uh-SAW-ruhs	tyrant lizard

** The name in parentheses is more accurate.

Glossary

Amber	fossil resin or gum from ancient trees like pine trees.
Ammonites	extinct octopus-like animals that had coiled shells with chambers and measured up to seven feet across. They lived in the oceans during the age of dinosaurs.
Armour (in dinosaurs)	bony plates, horns, spikes, or shields which serve to protect the animal
Armoured dinosaurs (nodosaurs)	heavy plant-eating dinosaurs that lived near Cretaceous swamps. They had a protective covering of bony plates on their backs; some had bony spikes along their sides, others had heavy bony tail clubs.
Badlands	areas heavily worn by wind and water into deep valleys of sheer cliffs and strange rock shapes.
Bayous	branches of streams that run through swamps.
Bipedal	walking on two legs.
Carcass	the dead body of an animal.
Carnivore	an animal that eats meat.
Carnivorous	flesh-eating.
Catastrophe	a violent or sudden change or great disaster.
Ceratopsians (horned dinosaurs)	cretaceous plant-eating dinosaurs with shields or flattened pieces of bone extending back from the skull over the neck. Some had horns on their noses or over their eyes (for example *Triceratops*).
Crest	a rounded area of bone on the top of the skull of some duck-billed dinosaurs that contained hollow passages.
Cretaceous	a Period of the earth's history (geologic time) that lasted from about 135 to 63 million years ago. During this time such great dinosaurs as *Tyrannosaurus* lived and at the end of the Period all the dinosaurs died out.
Deposit	to wash in mud and sand to form layers of sediments.
Deteriorate	to grow old and fall apart.
Deterioration	the process of decaying or falling apart.
Dominate	to rule over.
Dome-headed dinosaurs (pachycephalosaurs)	herbivorous Cretaceous dinosaurs which had a dome or cap-like thickening of bone on the top of the skull.
Dromaeosaurs	small, lightly built, Cretaceous, meat eating dinosaurs that ran about on two legs and ate small mammals, lizards, snakes, flying reptiles and birds.
Duck-billed dinosaurs (hadrosaurs)	large plant-eating dinosaurs that swam about in the Cretaceous swamps. These animals had a duck-like bill for shovelling up soft bottom plants, and some kinds developed hoods and crests on their skulls.
Embryo	the early form of an animal before it is born or hatched.
Environment	the surroundings in which animals and plants live.
Epoch	a lesser division of earth history (geologic time). Part of a Period, similar to a day or week in our modern time scale (year, month, week, day).

Era	the largest division of the geologic time scale.
Erosion	the wearing down of the land by water, wind and in some areas frost.
Extinct	no longer alive on earth, for example a kind of animal that has died out completely.
Extinction	the complete disappearance of a group of animals or plants.
Exposure	an area where rocks or layers of sediments are exposed or uncovered.
Fauna	all the animals that live together in a certain area, for example a forest or lake.
Flora	all the plants that live together in a certain area, for example a swamp or forest.
Flying reptiles (pterosaurs)	a group of reptiles that had wings of skin like modern bats and glided or flew over the Jurassic and Cretaceous swamps and oceans.
Fossil	the remains of an animal or plant that lived long ago and that has been turned to rock or preserved in some other way.
Fossilized	turned into a fossil.
Geologic time	the time that has passed during the history of the earth. It is broken down into Eras, Periods and Epochs.
Geologist	a scientist who studies the structure and history of the earth and its rocks and minerals.
Geology	the study of the history and structure of the earth and its rocks and minerals
Habitat	the kind of place in which an animal or plant lives.
Half-life (in rocks)	the length of time of decay or deterioration of radioactive elements.
Herbivore	an animal that eats plants.
Herbivorous	plant-eating.
Hood (in dinosaurs)	a high bony structure extending back from the skull in some types of duck-billed dinosaurs (for example *Lambeosaurus*) which often contains hollow areas and passages.
Horned dinosaur (ceratopsian)	Cretaceous plant-eating dinosaurs with shields or flattened plates of bone extending back from the skull over the neck. Some kinds had nose horns and horns over the eyes (for example *Triceratops*).
Hypsilophodont	a small, heavy bodied, herbivorous dinosaur that walked on two legs and lived on the higher ground around Jurassic and Cretaceous swamplands.
Isolated	to be alone, away from all similar things.
Jurassic	a Period of geologic time that occured from 181 to 135 million years ago. During this time dinosaurs like *Brontosaurus* and *Allosaurus* roamed the earth.
Living fossil	a plant or animal that has not changed a great deal for thousands or even millions of years and is still alive today. Examples include the gar pike, the maple tree, mosquitos, etc.
Marine	having to do with the ocean.

Mesozoic	the Era of geologic time during which the dinosaurs lived, which extended from about 220 to 63 million years ago and contained the Triassic, Jurassic and Cretaceous Periods.
Mimic	to imitate or try to look or act like.
Mosasaur	a large, carnivorous marine lizard that lived in the oceans during the Cretaceous. It had a body 20 to 25 feet long and like the monitor lizard with flippers or paddles instead of legs.
Oblong	a lengthened oval shape, like a sausage.
Ornithomimid (ostrich-mimic dinosaur)	a small, bipedal, Cretaceous dinosaur rather like an ostrich, that had a long neck and tail. This dinosaur had no teeth, but a beak like that of a bird and probably ate eggs and bugs.
Paleontologist	a scientist who studies fossils.
Period	a division of geologic time, part of an Era. For example the Cretaceous is a Period.
Plankton	one-celled plants and animals that live in the ocean and float about in large masses.
Plate (of bone)	a piece or block of bone embedded in the skin of a dinosaur.
Plesiosaur	a giant marine reptile that lived during the Jurassic and Cretaceous Periods. It had a body like a turtle with a long snake-like neck and tail and was 40 feet or more in length.
Porous	full of tiny holes, like a sponge.
Predator	an animal that hunts and kills other animals to eat the meat.
Preparator	a person who digs out, cleans, mends and mounts fossils like dinosaurs.
Prey	the animals killed and eaten by meat eating animals and plants.
Pterosaur (flying reptiles)	a group of reptiles that had wings of skin like modern bats and glided or flew over the Jurassic and Cretaceous swamps and oceans.
Quadrapedal	walking on four legs.
Remains	parts of a dead or fossilized animal or plant such as bones and teeth.
Salamander	a small animal that looks like a lizard, but is an amphibian - lays soft eggs in water and must spend at least part of its life in water.
Sauropods	a group of large, herbivorous, Jurassic and Cretaceous dinosaurs which included *Brontosaurus*.
Scavenger	an animal which eats the remains of the kill of a larger predator or a decaying carcass, but usually does not kill its own food.
Sediment	sand or mud or gravel deposited by water or wind, for example mud that is eroded off and washed into a stream or river.
Serrated	toothed or notched like the blade of a saw.
Shield (in dinosaurs)	a bony extension of the skull in horned dinosaurs that reached back to cover and protect the neck region.
Specimen	a sample for study. For example a rock or fossil is a specimen.
Subtropical	almost tropical, an area that is warm and humid and rich in plants.
Time scale	system used to measure time

Tropical	an area that is hot and very humid and full of lush plant life.
Triassic	the first Period of the Mosozoic Era, that lasted from 230 to 181 million years ago. Early in the Triassic the first dinosaurs appeared.

Suggested reading

Junior:

Andrews, Roy Chapman. *All About Dinosaurs*. Random House. 1953.
Fenton, Carroll L. *Life Long Ago*. The John Day Co. 1964.
Forbes, Duncan. *Life Before Man*. A.& C. Black, Ltd. 1959.
Geis, Darlene. *The How and Why Wonder Book of Dinosaurs*. Wonder Books. 1971.
Knight, Charles R. *Life Through the Ages*. Alfred A. Knopf, Inc. 1946.
McGowen, Tom. *Album of Dinosaurs*. Rand McNally & Co. 1972.
Reed, W. Maxwell. *The Earth for Sam*. Harcourt, Brace & World, Inc. 1960.
Whitaker, George O., and Meyers, Joan. *Dinosaur Hunt*. Harcourt, Brace & World, Inc. 1965.

Adult:

Augusta, Joseph. *Prehistoric Animals*. Paul Hamlyn. 1960.
Beiser, Arthur. *The Earth* (Life Nature Library). Time Inc. 1962.
Carr, Archie. *The Reptiles* (Life Nature Library). Time Inc. 1963.
Colbert, Edwin H. *The Dinosaur Book*. McGraw-Hill Book Co. 1951.
Colbert, Edwin H. *Dinosaurs*. E.P. Dutton & Co., Inc. 1961.
Fenton, Carroll L., and Mildred A. Fenton. *The Fossil Book*. Doubleday & Co., Inc. 1958.
Kurten, Bjorn. *The Age of Dinosaurs*. McGraw-Hill Book Co. 1968.
Moore, Ruth. *Evolution*. (Life Nature Library). Time Inc. 1962.
Swinton, S. W. *The Dinosaurs* . George Allen & Unwin Ltd. 1970.

Special References especially for teachers (that include information on Canadian dinosaurs and dinosaur hunting):

Braithwaite, Max. *The Western Plains* (Illustrated Natural History of Canada). N.S.L. Natural Sciences of Canada Ltd. 1970.
Brown, Barnum. *Hunting Big Game of Other Days: A Boating Expedition in Search of Fossils in Alberta, Canada*. National Geographic Mag., vol. 35, No. 5, pp. 407-429. 1919.
Colbert, Edwin H. *Men and Dinosaurs*. E.P. Dutton & Co., Inc. 1968.
Hardy, W.G. (Editor-in-chief). *Alberta: A Natural History*. M. G. Hurtig Pub. 1967.
Livingston, John A. *Canada* (The Illustrated Natural History of Canada). N.S.L. Natural Science of Canada Ltd. 1970.
Russell, Dale A. *The Dinosaurs of Canada*. Canadian Geographical Journal, vol. LXXV, No. 2, pp. 44-51. (Reprinted by the National Museum of Canada, 1967).
Russell, L.S. *Dinosaur Hunting in Western Canada*. Royal Ontario Museum, Life Sci. Contrib. 70. 1966.
Sternberg, C.H. *The Life of a Dinosaur Hunter*. Henry Holt & Co. 1909.
Sternberg, C.H. *Hunting Dinosaurs in the Badlands of the Red Deer River, Alberta, Canada*. Lawrence, Kansas, 1917.
Sternberg, C.M. *Canadian Dinosaurs*. National Museum of Canada, Geological series No. 54, Bull. 103. 1966.